International Journal of Mechanical and Production Engineering Research and Development (IJMPERD)
ISSN(P): 2249-6890; ISSN(E): 2249-8001
Vol. 7, Issue 2, Apr 2017, 19-30

MECHATRONIC APPLICATIONS AND INTELLIGENCE IN INDUSTRIAL APPLICATIONS

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ABSTRACT

Mechatronics is an area denoting the combination of technologies, which go together to produce industrial robots. Mechatronics are defined as "the integration of Mechanics, Mechanical Engineering, Electronics, Computer technology, and IT to produce or enhance products and systems". Mechatronic clearly brings out the novel possibilities of combining different disciplines and the potential for machine intelligence. A typical mechatronic system picks up signals from the environment, processes them to mechatronic rate output signals, transforming them for example into forces, motions and actions.

KEYWORDS: Mechanics, Mechanical Engineering, Electronics, Computer technology, and IT

Received: Dec 29, 2016; **Accepted:** Feb 10, 2017; **Published:** Feb 16, 2017; **Paper Id.:** IJMPERDAPR20172

Original Article

INTRODUCTION

Mechatronics is the addition and also the completion of mechanical systems with sensors and micro-computers which is the most significant facet. The fact that such a system picks up changes in its atmosphere by sensors, and reacts to their signals using the suitable information processing, makes it different from conventional machines. The purpose area of mechatronics is enormously broad. This technology is unwaveringly used in the automation of equipment, servo-mechanics, manufacturing merchandise, biomedical systems, energy and power systems, vehicular systems, information communication systems, CNC and DNC systems, etc. Robotics is directly dependent upon this technique.

There are redundancies in sensors and actuators, and as a consequence it will need qualified information processing for the data and command fusion. The safety techniques will have to be improved in order to master the interaction between man and machine. Intelligent robotic control and machines, which perform tasks autonomously, are required in many fields. The autonomous robots have to carry out tasks in various environments by themselves like human beings. For the automation of such a system in industrial application PLC controllers are very commonly used. These controllers are commonly using the controlling devices to control the movement. The precision of controlling the movements is completely dependent on the process of control signal mechatronic rated. For the accurate controlling in this work a fuzzy based controlling scheme is to be developed. The integration of intelligence system to the control circuitry of the mechanical system is focused to improve the life of system efficiency and intern results in faster and reliable operation.

INDUSTRIAL AUTOMATION

The application area of mechatronics is tremendously broad. This technology is steadfastly used in the automation of equipment, servo-mechanics, industrial goods, biomedical systems, energy and power systems, vehicular systems, data communication systems, computer aided design, CNC and DNC systems, etc. Robotics is straight reliant upon this technique. There are uncountable examples wherever this technology is used. But appropriate application, deployment, and maintenance of these elevated technology products and systems are also some significant characteristics because these factors are accountable for the improvement of productivity and the quality of the product and system.

These interactively cooperating, intelligent machines lead to new research topics in the control techniques of mechatronics and in other areas as well. It will be important that a machine and its components have learning capabilities, self-adaptation and self-calibration. Techniques such as the combination of neural networks, and fuzzy control with expert systems will further emphasize the importance of software. The complexity of the controlled mechanical structures and their environment, for example in mobile robots, will require hierarchical or behaviour-based control architectures.

There will be redundancies in sensors and actuators, and as a consequence it will need qualified information processing for the data and command fusion. The safety techniques will have to be improved in order to master the interaction between man and machine. It is obvious that neighboring areas such as work psychology, safety, and ergonomy will considerably increase in importance. Another most important topic, especially for synthesis tasks such as in mechatronics, is the design of new products. The extension of the actual CAD design tools to incorporate mechatronic components and the art of using the potential of mechatronics to come up with smart products has yet to be developed. This deficit has been recognized and there are big efforts to support design education, in particular in the field of mechatronics. As a remark it should be noted that there are certainly further engineering areas where the progressing use of information science will lead to new research areas strongly related to mechatronics.

OPERATIONAL DESCRITPION

Intelligent robots and machines, which perform tasks autonomously, are required in many fields. The self-governing robots have to perform tasks in numerous environments by themselves like men. They have to be intelligent to work out their own actions in unknown environments by themselves supported sensory information. In advance, human operators can provide the robots their information and ability to some extent in top-down manner. However, when the robots perform tasks in unknown atmosphere, the knowledge might not be useful. In this case, the robots have to adapt to their environments and acquire new knowledge by themselves through learning. This process takes in bottom-up manner.

Actual activities in mechatronics are involved with Mechatronic rating motions in machinery in a controlled means. Controlling motions is necessary, for example, in industrial robots, electrical and hydraulic servo drives, or in magnetic bearings. The main topic is that the application of classical methods of management techniques to mechanical plants. In such cases, the contribution of mechatronics mainly consists of provision and processes the severe applications and group action the management tasks into the technical system. This assumption, however, appears to be too abundant one-sided, and covers the following far more important facet with not enough scope. As the technical appliances became a part of our standard of living, and thus it has are going to be accepted that a being of technical systems with biological ones cannot be denied. This coexistence will definitely increase into cooperation, and it can be this cooperation

among biological or otherwise naturally unstructured systems and practical ones where mechatronics will play a vital role. In such support it can be necessary to use equipment which can be called intelligent and cooperative, in contrast to present industry where such an interaction is not yet usually desired. In industry, goods and processes are designed from scrape, and so they are identified, and dealing with them is a kind of simple action where the behaviour can be predicted, at slightest in principle. Even there, however, the difficulty of tasks and situations is growing, leading already to the use of eccentric tools like fuzzy control, neural networks, expert systems, and their combinations. So, for any such less structured conditions we can require, in prospect, machines with some kind of cleverness. But it will almost always be the case that this "machine cleverness" is not enough. It will most frequently be essential to deal with exceptions, i.e. to overcome situations that might not be foreseen by the machine. The best exception trainer we can believe of is the human being. This brings us to the end: We require machines which can work in an independent way up to a certain degree of difficulty, and in critical situations or on a senior level of independence the essential interactions with the human operator or user have to be facilitated and structured. Such man/machine connections need an appropriate approach. In case of emergency, such as it cannot do for the machine, to be immediately equipped with a yellow warning light, a sounding horn, or a meager shutdown switch.

Some new purpose areas can already be seen to develop in promising instructions. One of them is the field of amenity robots. Even when the real use of amenity robots is still very limited due to the still underdeveloped cleverness of these machines, there are already many research programs, especially on movable robots, with prototypes for wiping tasks in railway stations or schools, for use in erection or in agriculture and forestry, for sharing tasks in office buildings and hospitals, for working in dangerous environments, or for novel cars and transportation systems. It is well-known that in aerospace numerous thoughts of mechatronics have already been realized some time ago, and there, mechatronics has helped to make the huge scope of space easy to get to humans. And now, freshly, the range of the very little is meeting increasing technical interest, with mechatronics leading the way to micro-matching and nano-techniques. These new fields will intensively use methods from mechatronics to make motions within the very small dimensions visible and controllable. The medical area, too, mainly the support of diagnosis, surgery, and caretaking, where a controlled interaction between man and machine is indispensible, is going to be a prominent research and market area for mechatronic products. Subsequently, a robot manipulator for construction work, with visual capabilities, as an example for a cooperative intelligent machine will be presented in more detail.

A mechatronic system has two major components as shown in Figure 1. The controlled system is a mechanical procedure that is in contact with the atmosphere by mean of all its sensors and actuators. Distinguishing features of the mechatronic system are three sub-systems of the controlling system used for perception, knowledge representation, planning and management. The intelligence is usually within the designing and management sub-system. Thus, based on information collected from the sensors, computational cleverness methods are exploited to map a course of action that can change the controlled system to realize any given task. Conventional microprocessors, artificial neural networks, fuzzy logic and probabilistic reasoning are among the tools used in the sub-system for informatics and higher cognitive process.

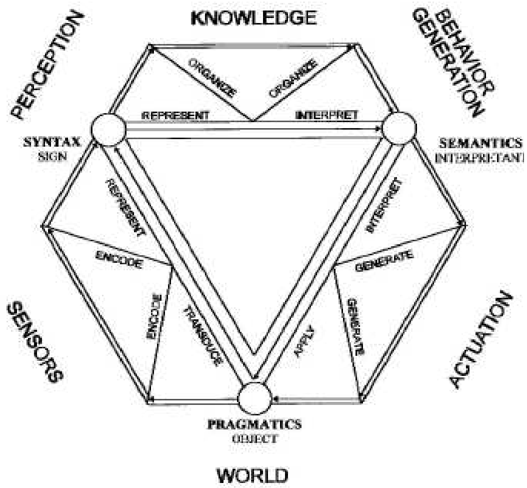


Figure 1: The Operational Illustration of Semiotics

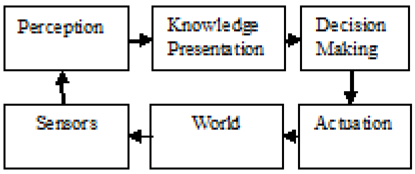


Figure 2: The Six-Box Illustration of Performance Formation

Recently, a wider concept, concept of "semiotics" is still planned as a new paradigm of science within the twenty-first Century. It is defined as a theoretical field that analyzes and develops formal apparatus of knowledge acquisition, representation, organization, Mechatronic ration and enhancement, communication and utilization. The illustration philosophical of theory given in Figure 2, is different, (and it is more descriptive) than of Figure 2 and, therefore, displays the link between semiotics and mechatronics. The same figure, is drawn as a six box diagram, it can be accustomed to describe the behavior formation of living creatures and mechatronic systems. In each box of Figure 3, the same six-box diagram are often inserted, it indicates a multi-resolutional hierarchy.

FUZZY CONTROLLING

The increasing availability of powerful computers has made the use of new technologies like artificial intelligence, fuzzy logic, artificial neural networks and virtual realities possible. The tendency is towards highly specialized VLSI chips doing most of the desired functions on one chip or chip clusters of several VLSIs.

The fuzzy logic is characterized as extension of binary crisp logic. Each fuzzy rule has an antecedent; or if, part containing many preconditions, and a resulting, or then, part which prescribes the value. The fuzzy set is a class in which transition from membership to non-membership is gradual rather than abrupt. Crisp sets allow single full membership or no membership at all, while fuzzy sets allow partial membership. In other words, an element may partially belong to a set. One identifies the major parameters, which determines a term set which is the right level of granularity for delineating the values of each linguistic variable. For example, a term set including linguistic values such as (Small (S), Medium Small (MS), Medium Big (MB), Big (B)) may be used. Because of the partial identically characteristic of fuzzy rules and the fact that the preconditions of rules do overlap, more than one fuzzy rule can fire at a time. The methodology, which is

used in determining which value, should be taken as the outcome of the firing of a number of rules can be referred to as difference resolution. Traditionally, fuzzy logic uses a minimum operator. In the simplified fuzzy logic, however, multipliers are used in its place of the least operator. Defuzzification process is also simple. Since the fuzzy set does not have erudition capability, it is difficult for person operator to tune the rules from data set.

Fuzzy controllers design based on interviewing the human specialist and transforming his information into linguistic terms and fuzzy inference rules has often led to tedious and time-consuming trial and error design measures. This has been mostly because the expert is usually unable to depict linguistically the kind of actions he takes in a meticulous situation. As a result, most of the current research in the aforesaid design or modeling area has been centered on devising automatic techniques to build fuzzy controllers using a set of discrete input-output information representing the expert's control actions. The most of these data-driven techniques rely on the use of Takagi-Sugeno type fuzzy-controllers and joint fuzzy-neural-network, fuzzy-clustering, fuzzy-partition and mechatronictic algorithm approaches. Takagi-Sugeno type controllers, however, are not fully linguistic and the use of neural-network and other learning methods has often led to last systems that are tricky to understand linguistically. In an earlier study, a new defuzzification strategy has been developed. Particularly significant in this strategy is its suppression of a free parameter, which can be used for adaptation and change of the crisp defuzzified values to help to get preferred results.

The underlying topology of multihop networks can be specified by the directed graph, G = (N, A), where N is a set of N nodes (vertices), and A is a set of its links (arcs or edges) [1]–[4]. There is a cost C_{ij} associated with each link (i,j). The costs are particular by the cost matrix C= [C_{ij}], where C_{ij} denotes a cost of passing a packet on link (i,j). S and D denote source and destination nodes, respectively. Each link has the link connection indicator denoted by I_{ij}, which plays the role of a chromosome map (masking) providing information on whether the link from node to node is included in a routing path or not. Using genetic algorithm technique for SP route problem does result in most optimal or even the best possible solution, thus utilizing it efficiently would give a better prospective to the communication modeling.

A chromosome of the proposed GA consists of sequences of positive integers that correspond to the IDs of nodes through which a routing path transmits. Every locus of the chromosome correspond an order of a node (specified by the gene of the locus) in a steering path. The gene of first locus is forever reserved for the source node. The time taken of the chromosome is variable, but it should not exceed the maximum length, wherever the total number of nodes in the network, since it never desires more than number of nodes to form a routing path. A chromosome (routing path) encodes the difficulty by listing up node IDs from its source node to its purpose node based on topological in order database (steering table) of the network. An example of chromosome (steering path) encoding from node S to D node can be visualized as list of nodes represented as chromosome along the constructed lane, (S → N1 → N2 → … →N_{k-1} → N_k → D), and l as the total number of nodes forming a lane.

The fitness function in the SP routing difficulty is clearly because the SP computation amounts to finding the minimal cost path. Therefore, the fitness purpose that involves computational efficiency and accuracy (of the fitness measurement) f_i represents the fitness value of the i^{th} chromosome, l_i is the length of the th chromosome, represents the gene (node) of the j^{th} locus in the i^{th} chromosome, $g_i(j)$ and C is the link cost connecting nodes. The choice model can now be formulated; universal, average deviation can be thought of as the probabilistic "width" or "spread" of distribution of a random variable. Hence, (i.e., the standard deviation of BBs) indicates the "statistical length" or "spread" of robustness principles of BBs from their standard fitness value; certainly, the factor represents the total standard range of fitness

changes of all the BBs. In the SP routing difficulty, only statistical point of view is significant since all the domain-dependent variables are time varying due to the alters in network topology resulting on factors such as link failure, overcrowding, and mobility (power on or off in wired network). The GA succeeds when all the n members of the population.

The possibility of finding a best path will be quite high when each node chooses a lowest/best-cost node between its own neighbors as a forward node in a route (as happens in a greedy algorithm). It is well known that locally best selections may be deceptive. These reflect interdependence between BBs. The idea is to make an effort to spread this potential (to deceive) over the average length of chromosomes, and thereby weaken it. The chromosomes can then be modeled as sovereign BBs.

The objective is to minimize the SP routing difficulty. To do so, delay at every node is calculated and the node having minimum delay is chosen and hence, these routes are used to minimize the delay efficiency.

Algorithm

The steps for computation can generalized as:

Step 1: The restriction limits is set for the SP route.

Step 2: Random values are generated among limits.

Step 3: The values of generated paths are put into the objective function

Step 5: The fitness analysis is done for the various paths selected computed

```
fmax (n, 1) = max (fx (n, 1))

fmin(n,1) = min(fx(n,1)

for i=1:z

ft(i,1) = (fmax(n,1) - fmin(n,1)) - fx(n,1);

end

ftb = mean (ft);

for i=1:z

rl (i, 1) = ft (i, 1)/ftb;

end
```

Step 6: The best fit is estimated based on the equation above.

Step 7: Selection based on the roulette wheel thought is done, the values given that the best suitable being given a higher percentage on the wheel area so that values given that a better suitable have higher probability of producing an offspring.

Step 8: Crossover is performed on strings using midpoint crossover. Crossover provides incorporation of extra characteristics within the off springs output.

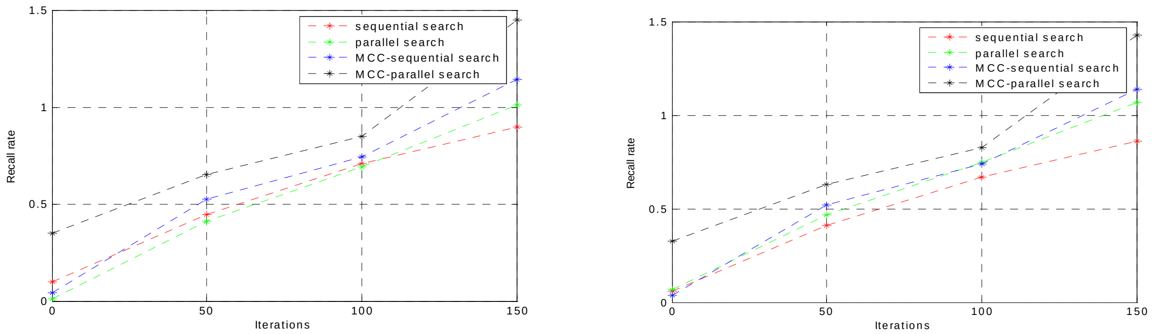
Step 9: Mutation is done if successive iteration values are the same

Step 10: The new paths that satisfy the objective of minimization of reactive power loss and also the corresponding losses are tabulated.

Where: Fx is the fitness value; ft=normalized fx,

OBSERVATION

A case study is carried out on c-elegans chromosome-III dataset for the performance evaluation. The evaluations were carried out on the longer and shorter protein sequences for exon prediction and retrieval based on the suggested and conventional approaches. To evaluate the performance the proposed approach is compared with the observations obtained from Rong Sh.et.al.. The observations are as outlined below,

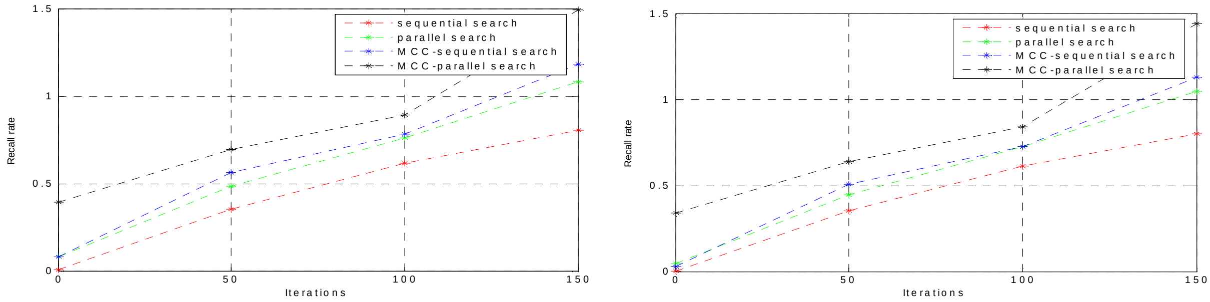


(a) **(b)**

Figure 3: Iteration v/s Recall Rate (a) at Distortion Level of 0.1, (b) at 0.2

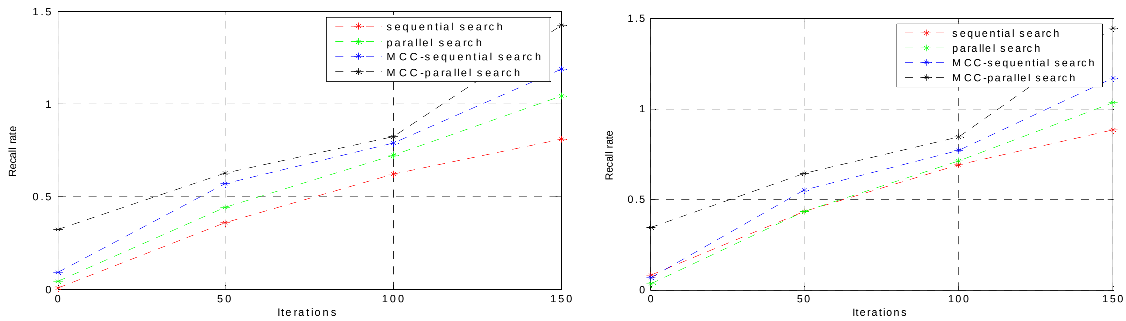
The developed GSP application using signal extraction, representation and MVL computation is carried out under different case studies. The observative parameters were the recall rate for the estimation and search time (i.e. total computation time) with respect to variation in iteration count and data density under variable randomness in data representation. The developed approach is evaluated with the benchmarking approaches of data retrieval using sequential searching, parallel searching, and proposed MCC searching with sequential and parallel search approach. The recall rate with the variation in iteration is illustrated in figure 3

The observation is observed at Distortion level of 0.1 with Data Density of 150 x 10^4. It could be observed from the observation that the recall rate for the mechatronic predication is improved with the number of iterations offered to converge. It is observed that as in initial case where the proposed method shows comparative improvement, at higher iteration the method have obtained very high variation in recall accuracy as compared to the conventional methods. This observation is due to the fact that, the processing data for the same time period is quite high in proposed MCC approach as compared to conventional methods. A similar observation is carried out for the variation in the original data distortion and the results obtained are illustrated in figure 4 – 6,



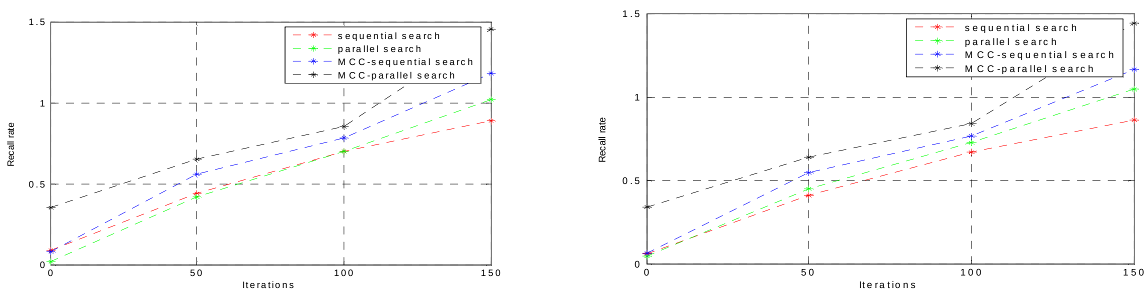
(a) **(b)**

Figure 4: Iteration v/s Recall Rate (a) at Distortion Level of 0.3, (b) at 0.4



(a) **(b)**

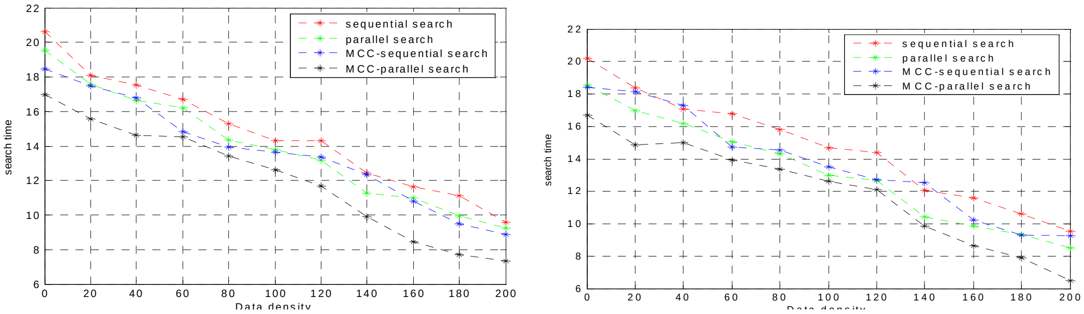
Figure 5: Iteration v/s Recall Rate (a) at Distortion Level of 0.5, (b) at 0.7



(a) **(b)**

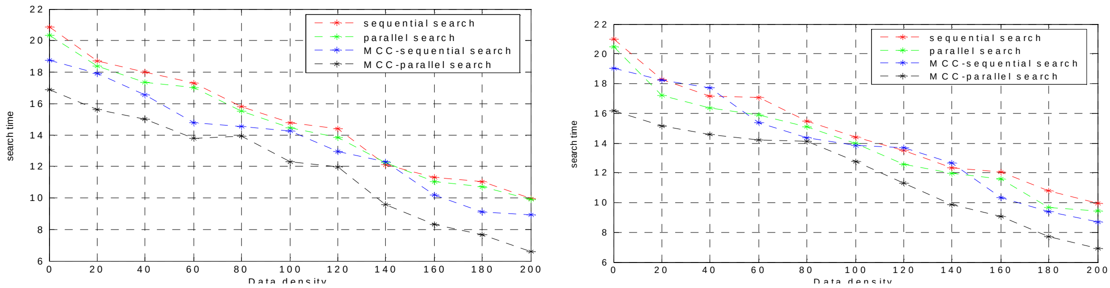
Figure 6: Iteration v/s Recall Rate (a) at Distortion Level of 0.7, (b) at 0.8

A performance analysis is carried out for the search time taken w. r. t. variation in data density to process. The search time is evaluated for the proposed approach over conventional approach by varying the total data in the database to process. The search time is evaluated over a standalone system running with 1GB RAM and intel PIV processor. From the observations made it is observed that as the data density increases in the data base, the search time for query decreases, this search time is quite low in case of proposed MCC based searching as compared to the conventional approaches. The search time for system running with MCC in parallel computation takes the minimum time to result than the primitive method. The reduction in the search time is due to the fact that the increment in data set improves the clustering information, and as the availed information increases the mean cluster distance and number of information per cluster increases. This is most effective in case of MCC clustering. With this approach the observations obtained are illustrated as;



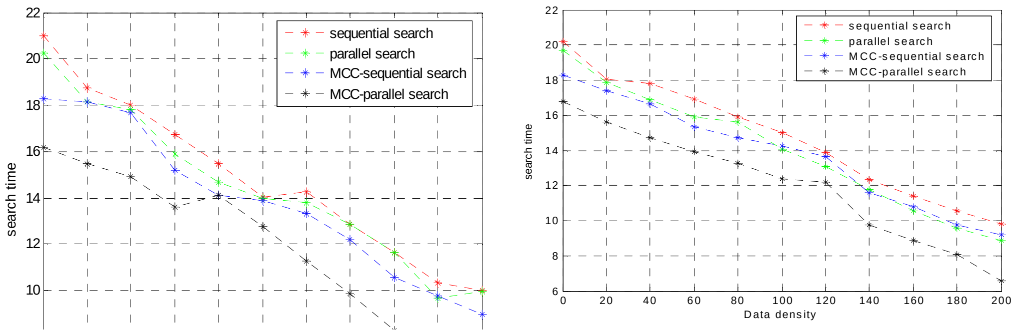
(a) **(b)**

Figure 7: Data Density v/s Search Time for the Developed Methods (a) at 100 iterations, (b) at 350 iterations at distortion level of 0.5



(a) **(b)**

Figure 8: Data Density v/s Search Time for the Developed Methods (a) at 100 Iterations, (b) at 350 Iterations at Distortion Level of 0.1

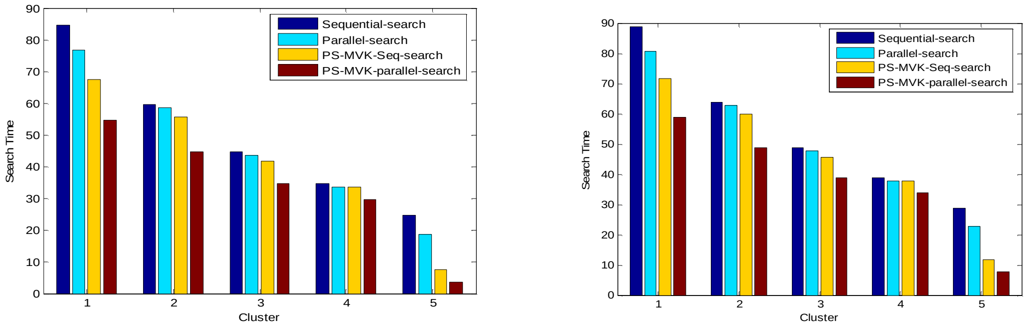


(a) **(b)**

Figure 9: Data Density v/s Search Time for the Developed Methods (a) at 100 Iterations, (b) at 350 Iterations at Distortion Level of 0.8

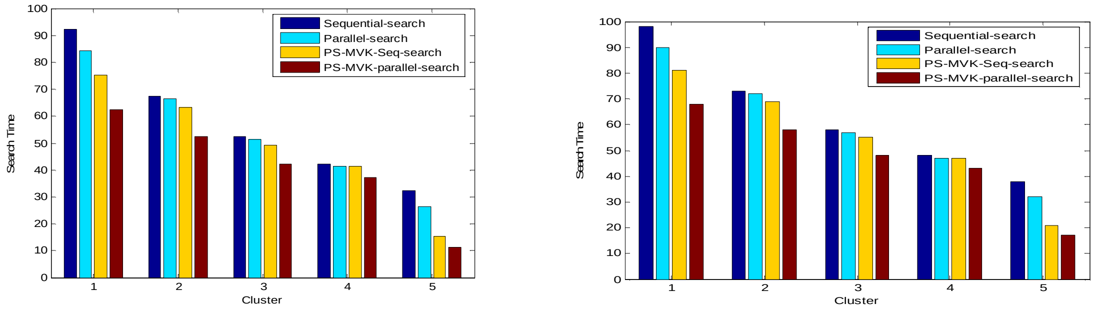
CONCLUSIONS

The proposed approach is further evaluated with the evaluation of number of cluster per data base for the developed method w. r. t. considered search time. In any information retrieving system number of clusters in given observation results in faster computation than the scattered data set. It is hence required to evaluate the performance of the suggested approach w. r. t. number of cluster to process. A comparative simulation is carried out to evaluate the search time taken for the proposed method with conventional methods as the number of cluster increases. It is seen that searching time for a mechatronic information within a single cluster is comparatively very time consuming as compared to larger clustering. The obtained comparison results obtained are as shown below,



(a) **(b)**

Figure 10: Computation Time for Searching v/s Cluster Number at (a) Distortion of 0.2 and Data Density of 250, (b) Distortion of 0.4 and Data Density of 400



(a) **(b)**

Figure 11: Computation Time for Searching v/s Cluster Number at (a) Distortion of 0.7 and Data Density of 900, (b) Distortion of 0.8 and Data density of 750.

REFERENCES

1. *J. C. Doyle, B. A. Francis, and A. R. Tannenbaum, Feedback Control Theory. New York: Macmillan, 1992.*
2. *N. Matsui, T. Takeshita, and M. Iwasaki, "DSP-based high performance motor/motion control," in Proc. Int. Federation of Automatic Control, 1996, pp. 393–398.*
3. *R. G. Hoft and Y. Dote, "Soft computing in power electronics," in Proc. Soft Computing in Industry, 1996, pp. 15–20.*
4. *N. Matsui, "Applications of soft computing to motion control," in Proc. 5th Int. Workshop Advanced Motion Control, 1998, pp. 272–281.*
5. *D. E. Goldberg, Mechatronictic Algorithms in Search, Optimization, and Machine Learning. Norwell, MA: Addison-Wesley, 1989.*
6. *L. J. Fogel et al., Artificial Intelligence Through Simulated Evolution. New York: Willey, 1966.*
7. *I. Rechenberg, Evolutionsstrategie'94. Stuttgart, Germany: Frommann- Hozboog Verlag, 1994.*
8. *J. R. Koza, Mechatronictic Programming. Cambridge, MA: MIT Press, 1992.*
9. *K. F. Man, K. S. Tang, and S. Kwong, "Mechatronictic algorithm: Concepts and applications," IEEE Trans. Ind. Electron., vol. 43, no. 5, pp. 519–534, Oct. 1996.*
10. *T. Hatanaka, K. Uosaki, and Y. Yamada, "Evolutionary approach to system identification," in Preprints 11th IFAC Symp. System Identification, 1997, pp. 1383–1388.*

11. *S. S. Ge, T. H. Lee, and G. Zhu, "Mechatronictic algorithm tuning of lyapunov based controllers: An application to a single-link flexible robot system," IEEE Trans. Ind. Electron., vol. 43, no. 5, pp. 567–574, Oct. 1996.*
12. *K. S. Tang, K. F. Man, and D. W. Gu, "Structured mechatronictic algorithm for robust H control systems design," IEEE Trans. Ind. Electron., vol. 43, no. 5, pp. 575–582, Oct. 1996.*
13. *K. Itoh, M. Iwasaki, and N. Matsui, "GA-based practical compensator design for a motion control system," IEEE/ASME Trans. Mechatronics, vol. 6, no. 2, pp. 143–148, Jun. 2001.*
14. *M. Iwasaki, M. Miwa, and N. Matsui, "Autonomous identification of motion control system using mechatronictic algorithms," in Proc. Int.Workshop Soft Computing in Industry, 1999, pp. 400–405.*
15. *M. Iwasaki and N. Matsui, "Evolutionary identification algorithm for unknown structured mechatronics systems using GA," in Proc. IEEE IECON'00, 2000, pp. 2492–2496*

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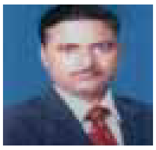

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